



# EVALUATING AND USING PERFORMANCE RECORDS OF BOARS AT CENTRAL TESTING STATIONS

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## CONTENTS

	Page
Introduction.....	1
Changes in Procedures.....	2
The Selection Index.....	5
Using Ratios and Deviation Records.....	8
Evaluating Test Records.....	10
Culling Tested Boars.....	14
Opportunities.....	14

1

# EVALUATING AND USING PERFORMANCE RECORDS OF BOARS AT CENTRAL TESTING STATIONS

Ben Bereskin<sup>1/</sup>

## INTRODUCTION

The National Swine Improvement Federation (NSIF) was formally organized in March 1975. That event signified a recognition by leaders of the American swine industry that the time had come to develop and implement more uniform and coordinated swine improvement programs in the United States. Key features of the NSIF efforts will be a more uniform central testing program for boars and revitalized on-the-farm testing programs. In addition, more uniform production-carcass competition will be promoted throughout the country. These testing components complement one another and, utilized together, will provide to the progressive swine breeder a better opportunity to keep pace in the fast-moving and highly competitive enterprise of swine breeding. This report examines various aspects of central testing and some of the applicable NSIF guidelines.

### Growth of Central Testing

Starting with the first station in Ohio in 1954, central testing has grown tremendously, with 40 public stations operating in 27 States as of June 1976. During that period, stations in different States or even within the same State operated their own testing programs, with varying standards, testing procedures, traits evaluated, and culling methods. The result was much confusion and greatly reduced overall benefits for the Nation's swine industry.

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Despite these and other deficiencies, central swine testing has been increasingly accepted by breeders and commercial producers alike. Perhaps the basic reason for this popularity is the general recognition that central testing stations can provide the best chance for fair and unbiased comparisons among individual boars, herds, and breeds. Environmental and management conditions can be kept relatively uniform and under strict and impartial control for all test pens included in a particular test at a station.

#### CHANGES IN PROCEDURES

Under NSIF guidelines, several major changes in testing and culling procedures will result. The aim is to provide a more uniform boar-testing program among central stations cooperating on a strictly voluntary basis.

##### Only Boars Tested

In the 1950's, most central stations tested only slaughter pigs. The Iowa Station, under Dr. L. N. Hazel, began testing boars in 1956. Gradually, other stations in the United States shifted to testing boars, but most stations continued to test slaughter sibs concurrently.

Over the past 3 or 4 years, the trend has accelerated to test only boars at central stations. As of June 1976, 37 of 40 central stations were testing boars. Nineteen of the 37 also tested slaughter sibs. Just three stations tested only slaughter sibs.

NSIF guidelines recommend that only boars be tested at central stations. Those guidelines do not prohibit testing of slaughter sibs or even litter slaughter groups. However, when cooperating stations test boars, NSIF guidelines are to be followed.

Testing only boars is in line with recent studies showing little if any support for use of slaughter sibs to evaluate the breeding value of boars at central testing stations. This is especially true for evaluating such traits as body composition, where backfat probes and ultrasonics appear to be fully adequate.

Slaughter-sib data appear to have only marginal value in estimating the genetic merit of boars for meat quality in general and that associated with PSE (pale, soft, exudative) pork. The PSE condition appears to be

partly under genetic control. It may be linked with the porcine stress syndrome (commonly known as PSS), for which blood tests may help identify susceptible animals.

Management immediately before, during, and after slaughter appears to have a significant effect on the incidence of PSE pork. These management conditions are usually not easily controlled at slaughter plants servicing most testing stations.

Meat quality also involves the tenderness, juiciness, flavor, and aroma of the pork. Judgment is therefore mostly subjective and susceptible to error. Also, meatpackers and processors are still not pricing slaughter hogs on the basis of pork quality.

Slaughter sibs undoubtedly have provided much useful educational and promotional value to central testing programs in the past. Now, considerations of space and expense of testing, plus the urgent need for more tested boars, generally outweigh such indirect benefits.

#### Full-Sib Test Pens

NSIF strongly urges that only full-sib (littermate) boars be tested together in the same pen. If adequate numbers of full sibs are not available, the breeder may include full- and half-sib (same sire but different dams) boars in the same test pen. The genetic basis for this recommendation is that full sibs on the average have about 50 percent of their genes in common, while half sibs have about 25 percent common genes. This genetic relationship allows a genetic appraisal of feed efficiency test data not possible with unrelated animals. Also, in the future, the performance of sib boars probably will be considered in evaluating other traits as well.

#### Traits Evaluated

A major question in any selection program is to decide which traits to consider in evaluating test animals. In the present situation, emphasis will be placed on a minimum number of traits that can adequately define the economic value of pigs to the commercial producer. These include measures of rate of gain, feed efficiency, and backfat thickness. NSIF recommends that appropriate measures of these three traits be combined in the form of a selection index to serve as the primary estimate



of breeding value of tested boars. In addition, soundness of feet and legs and of other physical features, such as teats and reproductive organs, also will need to be considered in evaluating test boars.

#### Criteria for Culling

NSIF further recommends that the specified selection index be the sole basis for culling test boars on their performance. Minimum soundness standards would be a supplementary criterion. This procedure represents a major departure from recent practices in which independent culling levels for separate traits have been utilized.

With independent culling levels, a minimum standard is set for each trait to be considered. If a boar does not meet a predetermined level for any one of those traits, it is eliminated from the test sale and usually from any breeding use. A common argument often given in favor of this method is its supposed simplicity and ease of application.

If strictly adhered to, independent culling levels usually involve comparisons of records of test animals with predetermined performance levels, rather than comparisons among records of animals within the same test group. Thus, conditions affecting all animals in a test group could have an undue influence on the number of animals culled.

For example, an outbreak of influenza throughout a test group might lower the performance levels enough to eliminate some good boars that might otherwise merit being used for breeding. Similarly, superior overall management might raise the performance level of all boars enough to save for breeding some boars that otherwise might be culled.

Also, if two traits are uncorrelated, we can save the top 20 percent of boars on their records for one trait and the top 20 percent on their records for the other trait, but only 4 percent of the boars would be in the top 20 percent for both traits. Thus it may be impossible to maintain the desired standards with independent culling levels where several traits need to be considered, which generally is the case. Perhaps the main disadvantage of independent culling levels is that creditable or even superior performance in one or more traits is not allowed to compensate for deficiencies in another trait.

## THE SELECTION INDEX

### Advantages

Selection indexes were designed as an improvement upon independent culling levels. The index takes into proper account the pertinent available information on the test animal, including the best estimates of heritabilities and genetic and phenotypic correlations. The boar's performance for each trait in the index is weighted according to its estimated relative economic importance. Performance in several traits is condensed into a single score or index which is the best estimate of the boar's true breeding value relative to other boars in the same test.

### Index Components

The traits included in the NSIF selection index are average daily gain (ADG) during the standard NSIF test period by the individual boar, in pounds per day; feed efficiency for the standard test period for the entire pen of boars, in pounds of feed consumed per pound of gross gain in weight for the entire test period (F/G); and average backfat thickness (BF) of the boar, in inches, as adjusted to the standard NSIF final test weight. BF may be determined either by probe or by ultrasonics, but by the same method for all boars in the same test.

Table 1 shows the heritabilities, standard deviations, and relative economic values assumed for the traits in the NSIF index. Table 2 shows the phenotypic and genetic correlations among the traits, used in computing the index.

Table 1.--Basic statistics assumed for traits

Trait	Heritability	Phenotypic standard deviation	Relative economic value (per unit)
ADG	30%	0.20 lb/day	\$4.00
F/G	35%	.26 lb feed/lb gain	9.00
BF	50%	.18 in	3.50

Table 2.--Correlations among traits

Trait	ADG	F/G	BF	Phenotypic correlations
ADG		-0.50	0.25	
F/G	-0.70		.15	
BF	.25	.30		

Genetic correlations

The relative economic values were computed as follows: A 0.1-lb increase in ADG will save about 6 days in putting on 200 lb to slaughter weight (such as from 30 to 230 lb). This saving is worth 78¢ per pig, assuming nonfeed costs of 13¢ per day, or \$7.80 for each pound increase in ADG.

For F/G of 3 lb feed/lb gain, 600 lb feed are needed to produce 200 lb gain. For F/G of 2.0, 200 lb less feed would be required, representing \$18/unit F/G, with feed at \$9/cwt.

Backfat value can be estimated from the difference in market value of hogs of different fatness. A value of \$7 per inch BF was assumed here. These values per unit change in the three traits were arbitrarily divided by 2 and rounded to the nearest half dollar, to give the relative economic values (table 1). (It should be noted that the values of \$8, \$18, and \$7 could just as well have been used in computing the index, because it is the relative, rather than the absolute, economic values, that are the critical factor.)

Costs of feed and other items, as well as the market value of hogs, fluctuate continually. The figures used here represent the average situation for 1976-77. Likewise, estimates of phenotypic and genetic parameters may change as new information becomes available. NSIF plans to monitor these basic statistics and to adjust the values in tables 1 and 2 as appropriate.

#### Recommended Indexes

NSIF has proposed two indexes for central testing stations, depending upon makeup of test pens. For boars tested individually, the proposed index is:

$$I_1 = 100 + 45 (\text{ADG} - \overline{\text{ADG}}) - 65 (\text{F/G} - \overline{\text{F/G}}) - 60 (\text{BF} - \overline{\text{BF}}).$$

For test pens of two or more boars, the proposed index is:

$$I_2 = 100 + 60 (\overline{ADG} - \overline{ADG}) - 75 (\overline{F/G} - \overline{F/G}) - 70 (\overline{BF} - \overline{BF}).$$

$\overline{ADG}$ ,  $\overline{F/G}$ , and  $\overline{BF}$  represent averages for the entire test group with the respective indexes.

Index  $I_2$  provides maximum accuracy for estimating breeding values of boars in test pens of full sibs, with lesser accuracy for boars in mixed pens of full- and half-sibs. It is not applicable for pens of boars having different sires. These indexes are formulated so that a higher value reflects better overall performance by the boar.

The indexes point up an important new feature of the NSIF program. Indexes are to be computed with differences (deviations) between a boar's performance for a trait and the average for the entire test group. Previously, a boar's actual performance record was used in computing the index.

#### Index Variation and Culling

As noted above, 100 is added to each index. As a result the average of all indexes in a particular test group will be 100 points and each index automatically corresponds to its percentage of the average index. The indexes are designed to vary about the average of 100, with a standard deviation of 25 points. This means that with normal variation in performance in a test group and with perhaps 50 or more boars included, we can expect, on the average, approximately the following distribution of index scores: 1/6 below 75 points, 1/5 below 80, 1/3 below 90, 1/3 between 90 and 110, 1/3 above 110, 1/5 above 120, 1/6 above 125, and only about 1 boar in 46 scoring above 150 points. Boars scoring over 125 points would surely be exceptional boars, at least in their performance.

According to NSIF guidelines, test stations are to offer for sale for breeding use only those boars that score 80 or above in their indexes. About 20 percent of tested boars would be culled by this method. Thus, boars would no longer be culled on the basis of independent culling levels, but on the basis of index scores. However, test station boars can also be culled on soundness, mainly of feet and legs, which constitutes a form of independent culling levels.

## USING RATIOS AND DEVIATION RECORDS

### Reporting Test Records

NSIF guidelines call for central testing stations to report each sale boar's performance for ADG, F/G, and BF as a percentage of the average for the entire test group. For example, suppose the ADG for a test group of boars is 2.0 lb/day. Included in the group are boar A with ADG of 1.8 lb/day and boar B with ADG of 2.3 lb/day. Boar A would then have a ratio of  $1.8/2.0$ , 90 percent of the test group average. Similarly, boar B would have a ratio of  $2.3/2.0$ , or 115 percent.

For F/G, each boar in a single test pen has the same value, the ratio of F/G for its pen to the average F/G of all pens in the test. For example, with a test group average of 2.75 for F/G, all boars in a pen with an F/G value of 2.50 have a ratio of  $2.50/2.75$ , or 91 percent. Ratios and percentages for BF will be computed on an individual basis, as for ADG. However, with both F/G and BF, the better performance would be indicated by a lower percentage. This is because we seek less backfat and a lower F/G ratio (greater feed efficiency) in our breeding animals.

Present NSIF guidelines also permit listing the actual performance record for each boar and the average for all boars for the three traits in the selection index. Other traits not included in the index, such as loin-eye area, days to final weight, and soundness score, need only be listed in actual values in sale catalogs and test summaries. However, if desired, all traits can be reported as percentages.

### Advantages

The immediate effect of using deviation and percentage records is to restrict comparisons to those among boars of the same test group. For example, a boar may score 105 percent for ADG, 95 percent for F/G, 85 percent for BF, and 110 points for index. These figures tell us that he was 5 percent better than average for both ADG and F/G, 15 percent better than average for BF, and 10 percent better than average for index. Because of the unequal valuations placed on the three component traits, the index score will usually not be the average of the scores for those traits.

The main reason for using deviations, ratios, and percentages instead of actual records is to eliminate or at least greatly reduce extraneous environmental effects on performance and thereby facilitate the genetic evaluation of boars. This is accomplished by comparing boars within a test group and scoring their performance accordingly.

Previously, using actual performance for component traits and the index, records varied widely from season to season and from one test station to another, often within the same State. Most such differences in performance are due to management and facilities rather than to genetic differences. The net result was to reduce the reliability of estimates of breeding values of test boars. This produced great confusion among prospective buyers who were trying to compare boars for possible purchase. Implementation of NSIF guidelines will go far toward putting boar evaluation on a sound basis, with emphasis on comparing individual boars and breeder herds in the same test.

Also, with deviation and percentage records, test stations can incorporate any new improved management systems, feeds, and facilities that may become available, without confusing breeders and buyers by changes in performance of test boars. This usually would not be the case with actual records.

A word of caution is advised in comparing boars tested at different times or at different stations. While most environmental effects will be removed under NSIF procedures, average genetic differences between groups in different tests will not be removed or accounted for by the new methods. Thus, care should be exercised in comparing deviation and percentage records for component traits and for the index from different tests.

The use of actual records is largely a matter of custom that has outlived its usefulness for evaluating genetic merit. The benefits of deviation and percentage records will become more apparent once they are adopted by central swine-testing stations and breeders and commercial producers become familiar with them. The value of such records for evaluating dairy and beef bulls is widely recognized. Deviation and percentage records can have a similar favorable impact on swine improve-

ment programs in the United States. NSIF deserves credit for taking the initiative in that direction.

#### EVALUATING TEST RECORDS

##### Expected Genetic Progress

The heritability of the proposed indexes is estimated at about 40 percent. This means that offspring of tested boars will average about 20 percent (half of 40 percent) of the superiority (or inferiority) of their sires in their own performance, assuming similar conditions for parents and offspring. For example, if boar A's index was 50 points above that for boar B, sons of boar A would be expected to average 20 percent of 50, or 10 index points above sons of boar B.

Individual sons would be expected to vary widely from this average difference. For example, sons of boar A would be expected to vary in their indexes from about 40 points below to about 60 points above the average of sons of boar B. Thus, superior performance of sires is not always reflected in superior performance of their sons.

It probably never will be possible to determine the true (exact) breeding values of test boars. However, the selection index is devised to maximize the correlation between the index and the breeding value of the animal. Rate of genetic progress from selection is directly proportional to this correlation. For the proposed indexes, this correlation,  $R_{IH}$ , is about 0.63. This means that by using indexes to evaluate and select boars, we can expect about 63 percent of the genetic progress that would be possible if we knew the true breeding values of tested boars and thereby could make correct selections. This correlation is less than perfect because of environmental and genetic complexities. However, substantial improvement in overall performance and economic value can be expected by continued use of above-average tested boars evaluated by the proposed indexes.

##### Relative Importance of Traits

Test station patrons are particularly interested in the relative importance attached to each component trait in the selection index. One useful measure is the relative contribution of each trait to the total variation of the index.

For boars tested singly, the separate traits account directly for about the following portions of index variation: ADG -- 15 percent, F/G -- 40 percent, and BF -- 20 percent, a total of 75 percent. With the index for two or more boars tested in a pen, contributions are ADG -- 23 percent, F/G -- 33 percent, and BF -- 24 percent, a total of 80 percent of index variation directly accounted for. The remaining variation in both indexes is due to the joint or correlated effects of the component traits.

Another measure of the importance of a trait is the reduction in  $R_{IH}$  resulting from removal of that trait from the index. These reductions are 8.5 percent by dropping ADG, 13.4 percent by dropping F/G, and 11 percent by dropping BF, for two or more boars per pen. Information on feed efficiency thus contributes the most to the overall genetic progress possible by use of the index.

Also of importance are genetic gains expected from selection on single traits as compared to gains expected from index selection. Table 3 shows the comparative genetic gains expected in each trait when 1 standard deviation (s.d.) of selection differential is applied to a particular trait or to the index. The selection differential is the amount that the average of those selected for use in breeding exceeds the average of the test group.

Table 3.--Comparative genetic gains (Index  $I_2$ )

Selection criterion	Trait			Net value
	ADG	F/G	BF	
	-----Percent-----			
ADG alone	100	46	-18	\$1.05
F/G alone	70	100	23	1.99
BF alone	-32	26	100	.88
Index	72	93	53	2.08

For example, in row 1 of table 3, selection was on ADG alone, with a selection differential of 1 s.d., or 0.2 lb/day (table 1). Therefore, the comparative genetic gain in ADG would be 100 percent. At the same time, the expected genetic gain in F/G would be only 46 percent of that expected for selection based solely on F/G. (A genetic gain in



F/G means a gain in feed efficiency and would be reflected in a lowering of the actual value of F/G). At the same time, however, the genetic merit for BF would be expected to decline (meaning an increase in BF) by 18 percent of the amount of improvement in genetic merit of BF for selection based only on BF. These results are due to the genetic correlations of F/G and BF with ADG (table 2).

On the other hand, exerting the same relative selection pressure (1 s.d.) on BF alone would decrease the genetic merit of ADG by 32 percent of the amount ADG would gain when selecting on ADG alone (line 3 in table 3). Differences in comparative responses between pairs of traits are due to differences in variability of the traits.

Line 4 of table 3 shows the results when 1 s.d. of selection pressure is applied directly to the index. The genetic gains expected in the separate traits relative to those expected from direct selection on the separate traits are 72 percent for ADG, 93 percent for F/G, and 53 percent for BF. This provides another measure of the relative emphases put on the component traits in the index and again shows F/G receiving the most attention.

It is also important to point out that all three component traits increase in genetic merit with index selection. This is not the case with single-trait selection for ADG or for BF.

#### Monetary Value

The above computations show that more genetic progress can be made in a component trait by single-trait selection than by use of the index. However, this does not indicate the overall benefits of index selection. To provide such a comparison, monetary values were computed on gains (or losses) expected in all three traits when 1 s.d. of selection pressure was applied to a component trait or to the index. Economic values of \$8/lb ADG, \$18/unit F/G, and \$7/in BF were used, reflecting economic values prior to reduction by 2, as used in computing the indexes (see page 6). The results are shown in the last column of table 3.

The net gain in total genetic merit expressed in monetary value is largest with index selection, slightly ahead of the net gain expected

from selection on F/G alone (\$2.08 vs. \$1.99), but far ahead of a comparable amount of selection pressure on ADG (\$1.05) or BF (88¢) alone. The results again confirm the advantage of index selection and the shortcomings of single-trait selection (especially for ADG and BF), which is essentially the same as independent culling levels in the present situation.

Selection on F/G alone is nearly equal to index selection and might be considered for single-trait selection. However, computing ADG and measuring BF at the completion of the standard test period are readily accomplished as routine procedures with little inconvenience. Data on ADG and BF then provide valuable supporting information on the genetic merit of the test boar, when used in the index.

#### Breeding Values of Boars

The actual changes in a boar's breeding value for each trait for each 10 points increase in score with index  $I_2$  are estimated to be 0.017 lb gain/day, -0.031 lb feed/lb gain, and -0.019 inch average BF. The net gain in monetary value from these expected changes per 10 points increase in index score is 84¢. This is based on economic values of \$8, \$18, and \$7 for ADG, F/G, and BF, respectively, and similar test conditions.

Only 20 percent (half the heritability of the index) of this added breeding value, or about 17¢, would be expected to be realized in each offspring of the boar, on the average. For example, if boar A indexes 30 points above boar B in a test, and each is to sire 500 pigs, the offspring of boar A would be expected to have a market value of  $3 \times 500 \times 17¢ = \$255$  more than 500 pigs sired by boar B. These two boars would presumably merit a comparable difference in their selling prices. This provides one method of determining a rough price tag to put on tested boars offered for sale.

A word of caution is advised on selecting boars. As noted earlier, we probably never will be able to learn the true breeding value of a boar from its appearance or even from its performance at a test station. With the built-in variability in the index estimate of a boar's breeding value, we can put a probability figure on real differences among boars.

For example, if boar A indexes 10 points over boar B, chances are about 2 in 5 that boar B is really the better breeding boar. For a difference of 20 points, chances are about 3 in 10 that the lower-index boar actually has a higher breeding value. Even with a difference of 30 index points, there is still nearly 1 chance in 5 that the lower-index boar has the higher breeding value. However, where indexes differ by 50 points, there is less than 1 chance in 12 that the lower-index boar is really better.

Similarly, boar A might be more superior to boar B than their indexes indicate. Thus, the buyer should remember that the index is subject to important sampling errors and that there is uncertainty attached even to the use of a properly tested boar. However, a much greater uncertainty is involved in using an untested boar.

#### CULLING TESTED BOARS

NSIF recommends that boars with indexes under 80 points be eliminated from the test sale and from use as breeders. On the average, about 20 percent of the boars in each test group would be culled by following this rule. Additional boars might be eliminated on general unsoundness. It is the general view in the industry that culling of some test boars is a good policy because it would encourage more careful selection of pigs consigned to testing stations and would eliminate some poor breeding risks from the population. The net result would be to raise the performance standards of boars offered for sale and thereby promote central testing stations as a reliable source of superior breeding stock.

Test station management probably should have some leeway in culling, depending on the general merit of the test group, the number culled for unsoundness and other causes, and the demand for boars. However, it should be the clear and full responsibility of local station management to use good judgment so that central testing stations do not become a dumping ground for inferior breeding stock.

#### OPPORTUNITIES

The success of central swine-testing stations will depend largely on their contribution to the genetic improvement of the swine population. Initial NSIF guidelines are not perfect nor are they permanent. Rather,

they will be continually reviewed and updated as conditions warrant. This includes the selection indexes discussed here.

As noted earlier, central testing is just one phase of the comprehensive swine improvement programs proposed by NSIF. Other important features include on-the-farm testing and production-carcass competition. NSIF programs offer the progressive swine breeder perhaps his best opportunity to improve his products and his efficiency of production and thereby to remain solvent in a highly competitive enterprise.

Implementing those programs would provide a major boost to the American swine industry in its efforts to stay competitive in this country and around the world. The success of NSIF efforts requires the full cooperation and support of all sectors of the industry.